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SPECIFICATION FOR AVIATION TURBINE FUELS, HIGH FLASH POINT TYPE

(Third Revision)

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SPECIFICATION FOR AVIATION TURBINE FUELS, HIGH FLASH POINT TYPE

(Third Revision)

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(*Continued on page* 19)

Indian Standard

SPECIFICATION FOR AVIATION TURBINE FUELS, HIGH FLASH POINT TYPE

(Third Revision)

0. FOREWORD

0.1 This Indian Standard (Third Revision) was adopted by the Indian Standards Institution on 15 November 1984, after the draft finalized by the Petroleum Products Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

0.2 This standard was originally published in 1960 and revised in 1967 and 1976. This third revision has been prepared as a result of a review of the standard in the light of the present day requirements of the product and in order to align it with specification No. D. Eng. R. D. 2498 (issue 7), 'Turbine fuel, aviation, high flash type', issued by the Ministry of Defence, UK, which is currently in use. The committee had also decided to adopt JFTOT method in place of the existing CFR Coker method for the determination of thermal stability which has been introduced in this revision accordingly.

0.3 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard prescribes the requirements and methods of sampling and test for aviation turbine fuels, high flash point type, used in turboprop and jet-engined aircrafts.

2. REQUIREMENTS

2.1 General — The material shall be clear, bright and free from undissolved water, and solid matter at normal ambient temperature.

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*Rules for rounding off numerical values (*revised*).

2.1.1 The material shall possess satisfactory properties and shall give good performance when used in appropriate aircraft or aeroengines or both.

2.2 Composition — The material shall consist completely of hydrocarbon compounds, except the materials specified in **2.2.1**, **2.2.2**, **2.2.4** and **2.2.5**.

2.2.1 *Antioxidants*

2.2.1.1 *Fuels which have been 'hydrogen treated'* — An approved antioxidant, or mixture of antioxidants, shall be added at the appropriate time during manufacture in order to prevent gum formation and peroxidation after manufacture. The total mass of active materials shall be not less than 17·0 mg/l nor more than 24·0 mg/l.

2.2.1.2 *Fuels which have not been 'hydrogen treated'* — An approved antioxidant, or mixture of antioxidants, may be added at the appropriate time during manufacture in order to prevent gum formation after manufacture. The total mass of active material(s) shall not exceed 24·0 mg/l.

2.2.1.3 The following are the approved antioxidants:

a) 2, 6-ditertiary-butyl-phenol;

b) 2, 6-ditertiary-butyl-4-methyl-phenol;

c) 2, 4-dimethyl-6-tertiary-butyl-phenol;

d) 75 percent, *Min*, 2, 6-ditertiary-butyl-phenols;

e) 25 percent, *Max*, tertiary and tritertiary-butyl-phenols; and

f) 55 percent, *Min*, 2, 4-dimethyl-6-tertiary-butyl-phenol;
15 percent, *Min*, 4-methyl-2, 6-ditertiary-butyl-phenol;
with the remainder a mixture of monomethyl and dimethyl-tertiary-butyl-phenols.

2.2.1.4 These antioxidants have wide and long standing usage. Other substituted phenols, and mixture thereof, are known to be equally effective. The use of alternative materials requires Design Authority consent (declaration of composition and evidence of satisfactory performance will normally be necessary).

2.2.2 *Metal Deactivator* — An approved metal deactivator may be added in amounts not exceeding 5·7 mg/l of active ingredient. The approved metal deactivator is N, N-disalicylidene, 1, 2-propanediamine.

2.2.3 The supplier shall, if required by the purchaser or his authorized agent, disclose the nature and concentration respectively of gum inhibitor and metal deactivator which have been added to his fuel supplies.

2.2.4 *Corrosion Inhibitor* — If agreed to between the purchaser and the supplier, an approved corrosion inhibitor may be added to the fuel. Edwin cooper additive Hitec E 515 (Santolene C) is an approved corrosion inhibitor which may be added at the time of delivery to the purchaser, in a concentration between 11·4 to 14·3 mg/l. The Hitec E 515 shall comply in all respect with the requirements given in Table 1.

TABLE 1 REQUIREMENTS FOR CORROSION INHIBITOR HITEC E 515 (SANTOLENE C)

SL No.	CHARACTERISTIC	REQUIREMENT	METHOD OF TEST, REF TO	
			Appendix	Method of IS : 1448*
(1)	(2)	(3)	(4)	(5)
i)	Ash content, percent by mass, *Max*	0·15	—	P : 4†
ii)	Flash point, Cleveland open cup, °C, *Min*	65·6	—	P : 69
iii)	Neutralization number, mg KOH/g	96 ± 5	A	—
iv)	Phosphorus, percent by mass	0·35 ± 0·07	—	P : 54
v)	Pour point, °C, *Max*	−26·1	—	P : 10
vi)	Sp. gravity at 15·6/15·6°C	0·875 ± 0·008	—	P : 16
vii)	Kinematic viscosity in cSt at 37·8°C	54 ± 9	—	P : 25

*Methods of test for petroleum and its products.

†To obtain accurate results for ash content, the crucible shall be heated for an extended period at high temperature. If a muffle furnace is used, the minimum temperature of 800°C for 3 or 4 hours is recommended but 900°C is preferable. Lower temperatures and inadequate time give high values. Variable results may be obtained because of the nature of the material.

2.3 The material shall also comply with the requirements prescribed in Table 2 when tested according to the appropriate methods prescribed under ' P ' series of IS: 1448* and Appendix ' B ' to this standard. Reference to the relevant test methods is given in col 4 and 5 of Table 2.

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*Methods of test for petroleum and its products.

TABLE 2 REQUIREMENTS FOR AVIATION FUELS HIGH FLASH POINT

Sl No.	Characteristic	Requirement	Method of Test, Ref to	
			Appendix	Method of IS : 1448*
(1)	(2)	(3)	(4)	(5)
i)	*Composition*			
	a) Acidity, total mg KOH/g, *Max*	0·015	—	P :†
	b) Acidity, inorganic	Nil	—	P : 2 (*see* Note 1)
	c) Aromatics, percent by volume, *Max*	25·0	—	P : 23
	d) Olefins, percent by volume, *Max*	5·0 (*see* Note 2)	—	P : 23 or P : 48
	e) Sulphur, total percent by mass, *Max*	0·30	—	P : 34
	f) Sulphur, merceptan percent by mass, *Max*	0·001	—	P : 36 (Method B)
	OR			
	Doctor test	Negative	—	P : 19
ii)	*Volatility*			
	a) Distillation:		—	P : 18 (*see* Note 3)
	1) Initial boiling point, °C	Report		
	2) Fuel recovered:			
	10 percent by volume at °C	205, *Max*		
	20 percent by volume at °C	Report		
	50 percent by volume at °C	Report		
	90 percent by volume at °C	Report		
	3) End point, °C	300, *Max*		
	4) Residue, percent by volume	1·5, *Max*		
	5) Loss, percent by volume	1·5, *Max*		
	b) Flash point, °C	60, *Min*	—	P : 21
	c) Density at 15°C, Kg/l	0·788, *Min* 0·845, *Max*	—	P : 16

(*Continued*)

TABLE 2 REQUIREMENTS FOR AVIATION FUELS HIGH FLASH POINT — *Contd*

Sl No.	Characteristic	Requirement	Method of Test, Ref to	
			Appendix	Method of IS : 1448*
(1)	(2)	(3)	(4)	(5)
iii)	*Fluidity*			
	a) Freezing point, °C	−46, *Max*	—	P : 11
	b) Kinematic viscosity at −20°C, cSt, (mm^2/s)	8·8, *Max*	—	P : 25
	c) Kinematic viscosity at −35°C, cSt, (mm^2/s)	To be reported	—	P : 25
iv)	*Combustion*			
	a) Specific energy, net, J/g, *Min*	42 600 (*see* Note 2)	—	P : 6 (*see* Note 4)
	OR			
	Aniline gravity product, *Min*	4 500 (*see* Note 2)	—	P : 3 (*see* Note 5)
	b) Smoke point, mm, *Min*	20 (*see* Note 2)	—	P : 31
v)	*Corrosion*			
	a) Copper strip corrosion classification for 2 h at 100°C, *Max*	1	—	P : 15
	b) Silver strip corrosion, *Max*	Zero (*see* Note 6)	B	—
vi)	*Stability*			
	a) Thermal stability (JFTOT)		—	P : 97 (with the modification as given in Appendix C)
	1) Filter pressure differential, mm Hg, *Max*	25·0		
	2) Tube rating, visual	Less than 3, no ‘ Peacock ’ or ‘ Abnormal ’ colour deposits		
	OR			
	TDR, Spun, *Max*	17, no ‘ Peacock ’ or ‘ Abnormal ’ colour deposits (*see* Note 7)		

(*Continued*)

TABLE 2 REQUIREMENTS FOR AVIATION FUELS HIGH FLASH POINT — *Contd*

Sl No.	Characteristic	Requirement	Method of Test, Ref to	
			Appendix	Method of IS : 1448*
(1)	(2)	(3)	(4)	(5)
	b) Oxidation stability (16 h aging)		—	P : 28 (Method B)
	1) Total gum content mg/100 ml, *Max*	14		
	2) Precipitate, mg/100 ml, *Max*	To be reported separately		
vii)	*Contaminants*			
	a) Existent gum mg/100 ml, *Max*	7	—	P : 29 (Steamjet method)
	b) Water reaction		—	P : 42 (Method A)
	1) Interface rating, *Max*	1b§	—	
	2) Separation rating, *Max*	2‖		
	c) Water separation index, Modified (WSIM): (*See* Note 8)	—	—	P : ‡ (*see* Note 9)
	1) Fuel with corrosion inhibitor/lubricity improving additive, *Min*	70		
	2) Fuel without corrosion inhibitor/lubricity improving additive, *Min*	85		

NOTE 1 — The sample size for the test shall be 100 ml.

NOTE 2 — Test for hydrogen contents in Aviation Turbine fuel has been introduced by D. Eng. RD Specification and it is expected to become a mandatory requirement in due course. In the interim, if a determination of hydrogen content is made and a result of 13·8 percent mass or greater obtained, the requirements for determination of olefins, specific energy, aniline gravity product and smoke point are waived. This value of hydrogen content 13·8 percent has been selected arbitrarily without reference to any future definitive value which will be based on the data to be gathered.

NOTE 3 — A condenser bath temperature of 0 to 4°C shall be used.

NOTE 4 — Class capsule shall be used to contain the sample. The gross heat of combustion or calorific value shall be corrected to 25°C by adding to it a quantity equal to 1·0 ($T - 25$), where T is the final temperature in degrees Celsius. The

(*Continued*)

TABLE 2 REQUIREMENTS FOR AVIATION FUELS HIGH FLASH POINT — *Contd*

net or lower heat of combustion shall be calculated from the gross heat of combustion by the formula:

$$4310/1\cdot8 + 0\cdot719 \times \text{gross cal/g}$$

For conversion from cal/g into jg multiply with 4·185.

Note 5 — Convert the aniline point determined in degrees centigrade to degrees Fahrenheit. Also find out the API gravity at 60°F from density figure at 15°C using the ASTM/IP Table No. 3. Alternatively, calculate API gravity from the sp. gravity in accordance with the following formula:

$$\text{Degree API} - \frac{141\cdot5}{\text{Sp. Gravity at } 15\cdot6/15\cdot6^\circ\text{C}} - 131\cdot5$$

An estimate of net specific energy (in units of MJ/Kg) can be made from Aniline Gravity Product using either Table No. 3 or equation 3 & 5 of joint method ASTM-D 1405/IP-193.

Note 6 — This limit is applicable at the refinery stage. However, at the point of delivery to the aircraft, a limit of 1 *Max* is permitted by 4 h test IP 227/81.

Note 7 — In case of dispute the tube rating ' visual ' shall be the referee method.

Note 8 — This requirement applies only on production or upon establishment of a main batch. Failure to comply with the specification requirement on later stage in distribution shall be cause for investigation and not for rejection in the first instance.

Note 9 — If the sample contains sediment for insoluble matter, it shall be allowed to stand and clear fuel decanted for testing. The sample shall not be filtered.

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*Methods of test for petroleum and its products.

†Under preparation. Till such time as it is published. The method given under ASTM-D 3242-78/IP 354/81 may be followed.

‡Under preparation. Till such time as it is published. The method given under ASTM-D 2550 may be followed.

§Small, clear bubbles covering not more than an estimated 50 percent of interface and no shreds, lace, or film at the interface.

||Complete absence of all emulsions or precipitates, or both, within either layer or upon the fuel layer, except small air bubbles or small water droplets in the fuel layer.

2.4 Special Requirements — The material if refined by the copper sweetening process shall not contain more than 150μg/kg of copper. For determining copper content, the method given under IP 225 may be followed with the modification given in **2.4.1**.

2.4.1 Dry the sample by shaking it with anhydrous sodium sulphate or calcium chloride and allowing it to stand in contact with the drying agent for at least an hour. Filter it through a sintered glass crucible or a filter paper (such as, Whatman No. 4 or its equivalent) into a dried test tube.

3. SAMPLING

3.1 Representative samples from the homogeneous stock of the material shall be drawn as prescribed in IS : 1447-1966*.

3.2 Number of Tests — All characteristics given in the specifications shall be tested on the composite sample.

3.3 Criteria for Conformity — The lot shall be declared as confirming to the requirements of the specification if all the test results on the composite sample meet the relevant specification requirements.

4. PACKING AND MARKING

4.1 Packing — The material shall be packed in suitable containers as agreed to between the purchaser and the supplier subject to any rules and regulations in force in the country.

4.2 Marking — The material shall be supplied in accordance with the marking and delivery instructions given by the purchaser.

4.2.1 Each container shall be marked with the following information:

a) Name and grade of the material;
b) Manufacturer's name, initials or trade-mark, if any;
c) Volume of the contents in litres; and
d) Year of manufacture or packing.

4.3 BIS Certification Marking

The product may also be marked with Standard Mark.

4.3.1 The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

5. HANDLING AND STORAGE

5.1 For the safe handling and storage of fuel, instructions and guidelines given in IS : 7667-1975† should be followed.

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*Methods of sampling of petroleum and its products.

†Code of practice for handling and storage of aviation fuels at airfield fuelling stations.

APPENDIX A

[*Table* 1, *Sl No.* (iii)]

METHOD FOR DETERMINATION OF NEUTRALIZATION NUMBER FOR HITEC E 515 (SANTOLENE C)

A-1. PROCEDURE

A-1.1 Introduce 0·1 g of sample, weighed to the nearest 0·001 g into a 250 ml conical flask. Add 100 ml of *iso*-propyl alcohol previously neutralized to a pink phenolphthalein end point with 0·1 N potassium hydroxide solution and mix thoroughly.

A-1.2 Titrate with 0·1 N potassium hydroxide solution to a pink end point.

A-2. CALCULATION

A-2.1 Calculate the neutralization number using the following formula:

$$\text{Neutralization number} = \frac{A \times 5{\cdot}61}{M}$$

where

A = volume in ml of potassium hydroxide solution used; and

M = mass in g of the sample taken for the test.

APPENDIX B

[*Table* 2, *Sl No.* (v) (b)]

SILVER CORROSION BY AVIATION TURBINE FUELS

(Adapted from Institute of Petroleum, U. K. Method No. IP 227 T/68)

B-1. SCOPE

B-1.1 This method describes a procedure for the detection of the corrosiveness of aviation turbine fuels towards silver.

B-2. OUTLINE OF THE METHOD

B-2.1 A polished silver strip is completely immersed in 1 litre of fuel at 45°C ± 1°C for a period of 16 hours, or any longer period which may be specified. At the end of this period, the silver strip is removed from the sample, washed, and evaluated for corrosion.

B-3. APPARATUS

B-3.1 Conical Flask — 1 or 2 litre capacity, made of heat-resistant glass and fitted with B 29 ground glass socket.

B-3.2 Condenser — Coil type having an effective surface area of at least 300 cm² and fitted with B 29 joint.

B-3.3 Oven Incubator or Water Bath — Capable of maintaining the flask and its contents at a temperature of 45°C ± 1°C in the dark.

B-3.3.1 The oven or incubator shall be of such dimensions as to accommodate the flask. The water bath shall be shielded from light to keep the sample in the dark, for example, by means of a suitable lid or by painting the flask black.

B-3.4 Strip Vice — For holding the silver strip firmly without marring the edges. The type specified in IS : 1448 [P : 15]-1976* is suitable.

B-3.5 Support — Bent glass rod conforming to the requirements shown in Fig. 1. An acceptable alternative is to suspend the strip by means of fine nylon thread.

B-3.6 Test Tube — Flat, similar to that given in IS : 1448 [P : 15]-1976* is suitable.

B-3.7 Thermometer — ASTM 12C/IP 64C or any other suitable thermometer capable of indicating the temperature of the bath within the limits given in **B-3.3**.

B-4. MATERIALS

B-4.1 *Iso*-octane — Conforming to the specification for ASTM knock test grade iso-octane.

B-4.2 Silver Strip — Assaying at 99·9 percent silver and having the dimensions of length 75 to 77 mm, width 12·5 to 12·7 mm and thickness 1·5 to 3·0 mm. The strips may be used repeatedly, but shall be discarded when they show pitting or deep scratches that cannot be removed or when the surfaces become deformed.

B-4.3 Polishing Materials — Silicon carbide or alumina grit paper of varying degrees of fineness including 240 grit silicon carbide paper or No. 00 emery cloth or equivalent; also a supply of 106 micron silicon carbide grain and pharmaceutical grade absorbent cotton wool.

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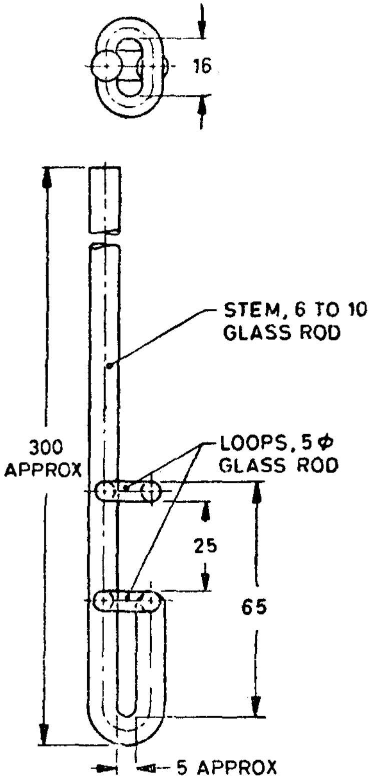
*Methods of test for petroleum and its products [P : 15] Copper strip corrosion test (*second revision*).



All dimensions in millimetres.

FIG. 1 SUPPORT FOR SILVER STRIP

B-5. PREPARATION OF STRIPS

B-5.1 Surface Preparation — Remove all surface blemishes from all six sides of the strip with silicon carbide or alumina grit paper sufficiently fine to accomplish the desired results (*see* Note). Finish with 240 grit silicon carbide paper or No. 00 emery cloth, or its equivalent, removing all marks that may have been made by other grades of paper used previously. Immerse the strip in *iso*-octane, from which it may be withdrawn when proceeding to the final polishing strip.

NOTE — As a practical manual procedure for surface preparation, place a sheet of the abrasive paper on a flat surface, moisten it with *iso*-octane, and rub the strip against the paper with a rotary motion, protecting the strip from contact with the fingers with an ashless filter-paper. Alternatively, the strip may be prepared mechanically, using appropriate grades of dry paper or cloth.

B-5.2 Final Polishing — Remove a strip from *iso*-octane. Holding it in the fingers protected with ashless filter paper, polish first the ends and then the sides with the 106-micron silicon carbide grains picked up from a clean glass plate with a pad of cotton wool moistened with a drop of *iso*-octane. Wipe vigorously with fresh pads of absorbent cotton and subsequently handle only with stainless steel forceps; *DO NOT TOUCH WITH THE FINGERS.* Clamp in the vice and polish the main surfaces with the silicon carbide grains on absorbent cotton. Rub in the direction of the long axis of the strip, carrying the stroke beyond the end of the strip before reversing the direction. Clean all metal dust from the strip by rubbing vigorously with clean pads of absorbent cotton until a fresh pad remains unsoiled. Immerse the strip in the sample within 1 minute of completing the final polishing.

NOTE — It is important to polish the whole surface of the strip uniformly to obtain a uniformly stained strip. If the edges show wear (surface eliptical) they are likely to show more corrosion than the centre. The use of a vice facilitates uniform polishing.

B-6. SAMPLE

B-6.1 It is particularly important that care is taken during sampling and subsequent handling to eliminate aeration of the sample and to protect them from exposure to direct or even diffused daylight. Samples of 1 litre minimum size shall be collected in containers which will not affect the corrosion properties of the fuels (*see* Note). Clean dark brown bottles are preferred. Fill the container to leave not more than 5 percent ullage and close it immediately after taking the sample. Store the sample in a cool place, preferably below 4°C. Test the sample as soon as possible after receipt and immediately after opening the container.

NOTE — Experience has shown that tinplate containers are particularly bad in this respect.

B-6.2 If suspended water (haze) is observed in the sample (*see* Note), filter through a medium rapid quantitative filter paper (for example, Whatman No. 1 or No. 4) into the clean, dry flask. Carry out this operation in a darkened room or under a light protected shield.

NOTE — Contact of the silver strip with water before, during or after completion of the test run, will cause staining, making it difficult to evaluate the strip.

B-7. PROCEDURE

B-7.1 Pour 1 litre of the sample into the clean conical flask. Fit the condenser to the flask (*see* Note). Insert a freshly polished strip into the support or, alternatively, suspend it vertically by means of a nylon thread loop. Carefully lower the strip into the sample.

NOTE — If the initial boiling point of the sample is above 100°C, a vented cork may be substituted for the condenser.

B-7.2 Place the flask in the oven, incumbator or water bath and maintain the temperature at 45 ± 1°C for 16 hours or for any longer period which may be specified. Keep the sample in total darkness for this period. At the end of the test period remove the silver strip from the flask with stainless steel tongs and immerse it in *iso*-octane. Withdraw the strip immediately, dry it with quantitative filter paper (by blotting, not wiping), and inspect it for evidence of corrosion.

B-8. INTERPRETATION

B-8.1 Interpret the corrosiveness of the sample according to the appearance of the test strip by means of the classification given in Table 3.

TABLE 3 SILVER STRIP CORROSION CLASSIFICATION

CLASSIFICATION	DESIGNATION	DESCRIPTION
0	No tarnish	The same as freshly polished strip, except possibly for some very slight loss of lustre.
1	Slight tarnish	Faint brown or white discolouration of strip.
2	Moderate tarnish	Surface of strip showing various shades of blue and mauve.
3	Slight blackening	Patches of black on surface or uniform thin film of black deposit.
4	Blackening	Uniform heavy blackening with or without scaling.

B-8.1.1 The provisions of suitable colour standard plaques is being investigated.

B-9. REPORT

B-9.1 Report the result as silver corrosion followed by the pertinent classification number from Table No. 3 and duration of test.

APPENDIX C

[*Table* 2, *Sl No.* (vi) (a)]

THERMAL OXIDATION STABILITY OF ATF BY ALCOR JET FUEL THERMAL OXIDATION TESTER (JFTOT METHOD)

C-1. GENERAL

C-1.1 Tests shall be carried out according to IS : 1448 [P : 97]-1980* with the amendments given in **C-2** below and using the following test conditions:

a) Heater tube temperature	260°C
b) Fuel system pressure	3·45 MPa
c) Fuel flow rate	3·0 ml/min
d) Test duration	150 minutes

C-2. MODIFICATIONS TO THE PROCEDURE LAID DOWN IN IS : 1448 (P : 97)-1980*

a) Following **6.6.1**, add new para **6.6.1.1**:

6.6.1.1 *Pre-inspection of heater tube* — Prior to assembly each heater tube shall be placed in the tuberator (*see* **9.1**). The middle (test) portion of the tube, namely the samll diameter portion of the heater tube shall be inspected for scratches, dull unpolished area, or other visual defects. Any evidence of visual defects is casued for rejection of the tube. Also the tube shall be examined for straightness. This may be done by placing the tube on a flat surface and rolling it while looking at the gap between the middle part of the tube and the flat surface. If the gap is seen to change in size while rolling, the tube shall be rejected.

NOTE — Whenever handling the heater tube care shall be taken to ensure that the test portion of the tube is not touched or damaged in any way.

b) *Prior to para* **9.1** *insert*:

Examination of the heater tube to determine either the Tube Rating, Visual of TDR, Spun, shall be carried out within 120 minutes of completion of the test.

c) *To para* **9.1.5** *add the following:*

The portion of the test section between 15 mm and 50 mm above the bottom shoulder of the heater tube test section shall be examined carefully using a magnifying glass in conjunction with the Tuberator for any signs of discolouration, scratches, or other visually identificable defects.

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*Methods of test for petroleum and its products [P : 97] Thermal oxidation stability of aviation turbine fuels (JFTOT Method).

NOTE — It is important that all light bulbs in the Tuberator are functioning as a change in light intensity can shift the rating significantly. The person rating the tube should have normal ability to distinguish between colours, namely, he should not be colour-blind.

d) *Following para* **9.1.6** *add*:

9.1.6.1 In rating the heater tube the darkest deposits govern, and the code number representative of the darkest section rather than the average deposit, shall be reported.

9.1.6.2 If a spot or streak is found on the heater tube, it shall be examined carefully under various lighting conditions using a magnfying glass to determine if it is a deposit a scratch or a tube defect (noti that any tube defects; should have been found during the pre-test inspection of the tube). If the spot or streak is determined to be a scratch or tube defect, it shall be disregarded. It the spot or streak is a deposit, it shall be rated against the ASTM Colour Standards if larger in area than about 2·5 mm^2, that is approximately 1·5 mm^2 or an equivalent area. However, a streak deposit shall be ignored if less than 0·8 mm wide, regardless of length.

NOTE — Since the tube test section is about 3 mm in diameter; thus a 1·5 mm wide spot is 1/2 the diameter of the tube test section and a 0·8 mm wide streak is 1/4 diameter of the tube test section.

9.1.6.3 If some part of the deposit does match the Colour Standards, it shall be rated. However, if the heater tube has deposits which do not match the Colour Standards, the following criteria shall be used.

9.1.6.3.1 If the deposit includes peacock (rainbow) colours, rate these as Code ' P ' (' P ' for peacock).

9.1.6.3.2 If the deposit includes abnormal colours (for example, blue or grey), rate these as Code ' A ' (' A ' for abnormal).

9.1.6.3.3 When reporting, the overall tube rating, record the rating of the maximum deposit which matches the Colour Standards plus ' P ' and/or ' A ' if the tube also has deposits which do not match the Colour Standards. If the tube contains only ' P ' and/or ' A ' deposits, just report the appropriate letter(s), do not try to assign a numerical rating to a ' P ' and/or ' A ' deposit. Examples of how the rating procedure is to be used are given below:

Example 1 — The darkest deposits on the heater tube match Colour Standard 1. Also present are peacock colours. Thus the overall tube rating to be reported is ' 1P '.

NOTE — This result is a ' fail '.

Example 2 — The heater tube has maximum deposits falling between Colour Standards 2 and 3 and has no peacock or abnormal colours. The overall tube rating is ' less than 3 '.

NOTE — This result is a ' pass '.

Example 3 — The heater tube matches Colour Standard 1 except for an abnormal deposit which does not match the Colour Standards. The overall tube rating to be reported is ' 1A '.

NOTE — This result is a ' fail '.

e) *Replace para* **9.3.5** *by the following:*

9.3.5 To obtain the maximum SPUN deposit rating, slowly scan from a TUBE POSITION indicator reading of 15 to 50, noting the position of maximum reading. Record this reading as the maximum SPUN deposit rating.

9.3.5.1 After determining the maximum spun rating, remove the heater tube from the TDR and examine it visually using the Tuberator, for the presence of peacock (rainbow) and/or abnormal (for example, blue or grey) colour deposits.

9.3.5.1.1 If the deposit includes peacock colours, rate these as code ' P '.

9.3.5.1.2 If the deposit includes abnormal colours, rate these as code ' A '.

9.3.5.1.3 When reporting the overall tube rating, record the maximum spun rating, plus ' P ' and/or ' A ' if the deposit includes peacock and/or abnormal colours respectively. Examples of how the rating procedure is to be used are given below:

Example 1 — The heater tube has a maximum spun rating of 2 and peacock colours are found to be present when the tube as examined in the Tuberator. The overall tube rating is to be reported as ' TDR 12P '.

NOTE — This result is a ' fail '.

Example 2 — The heater tube maximum spun deposit rating has been determined as 15, no abnormal or peacock colours are present. The overall tube rating is ' TDR 15 '.

NOTE — This result is a ' pass '.

Example 3 — The heater tube maximum spun deposit rating has been determined as 15 but abnormal colours are present. Report the result as ' TDR 15A '.

NOTE — This result is a ' fail '.

(*Continued from page* 2)

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